Habitat attribute protocols used for watershed condition monitoring/surveys (in wadable streams)
Based on agency input and website info (7/2/03)[1]
Steve Lanigan - editor

Common protocols
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Questions about protocols

Parameter Measured	Aquatic and Riparian Effectiveness Monitoring Program (AREMP)[2]	Pacfish/Infish Biological Opinion (PIBO)[3]	National Park Service (North Cascades NP)[4]	Oregon DEQ and Oregon Plan[5]	Washington DOE and Comprehensive Monitoring Strategy[6]	California North Coast Watershed Assessment[7]	Oregon Dept. Fish & Wildlife Stream Survey and BLM[8]	FS R6 Level II Stream Survey[9]	Action Agency (BPA, COE, BOR) and NMFS Research Monitoring and Evaluation Plan
Subwatershed (6^{th} Field HUC) No.	Boundaries follow REO delineated lines.	Currently using ICBEMP 6^{th} field HUC coverage. Lines will not match with the 5^{th} field coverage used by most of the BLM. The Effectiveness monitoring team will be acquiring the REO layer so they can present compatible 5^{th} field HUC numbers.	Undecided but likely 6^{th} field HUC and sub basins within HUCs. Are you using REO delineated HUCs?	Oregon Plan – ESU's and GCA's EMAP – Ecoregion and 4^{th} field HUC Ambient Program – Statewide TMDL's – 4^{th} Watershed basins are defined as area above sample points.	DOE: Ecoregions (Level III & IV). Water Resource Inventory Area (WRIA). EMAP and CMS - WRIA, ecoregions, salmon recovery regions. http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/fomws.html	31 North Coast hydrologic basins ranging from 68-1615 sq. mi divided into subbasins according to common attributes. These are based on "CAL water" units. http://www.ncwatershed.ca.gov Use REO 6^{th} HUCs for coho recovery program.	Surveys placed on GIS coverages. Can be summarized within 6^{th}, 5^{th}, or 4^{th} field HUCs. Are you using REO delineated HUCs?	Boundaries follow REO delineated lines.	Watershed boundaries are defined by the distribution of ESUs, populations, or subpopulation and may include different HUCs.
Reach Location	Sample site locations are randomly selected within watersheds using the EPA's GRTS design. Starting point of survey is located with GPS and recorded as UTM.	Reach locations are selected using 2 strata. 1) the lowest-most nonconstrained reach on public land (85% of sites) 2) And lowest most constrained reach on public land (15% of sites) Recorded as UTM at the upstream and downstream ends of the reach.	Tributary confluences, landmarks, changes in stream type – with GPS locations	Starting point of survey located with GPS and recorded as UTM.	Water Monitoring: Lower mainstem & reaches with frequent criteria violations. Biological Monitoring: Ambient Biological Monitoring uses targeted locations (upstream/downstream, reference, representing gradients of degradation). EMAP and CMS - uses probabilistic design methods for random	LLID is assigned to a stream at its confluence with its receiving stream. Event sites are located with GPS and usually by distance from LLID as well, using dynamic segmentation.	Record UTM coordinates at the beginning of the reach and at the end of all surveys, and mark on a 7.5-minute topo map.	Start and end points are recorded as River derived miles from 1:24000 USGS topo maps. Will be GIS generated in the future.	The program defines a reach as a relatively homogeneous stretch of stream having similar regional, drainage basin, valley segment, and channel segment characteristics. Reaches are identified by using a hierarchical list of classification variables. Reaches may contain one or more sampling sites. The boundaries of a

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					location of sites within a spatial area.				reach will be measured with GPS and recorded as UTM.
Reach Length	Reach length is 20x average bankfull width with minimum length of 150m and maximum of 500m. Reach lengths stratified into categories based on BFW. E.g., for 8-10 BFW, reach = 10x20 BFW. Reaches start at the closest pool tail to the randomly chosen UTM point.	Reach length is 20x average bankfull width with a minimum length of 150m and maximum of 320m. Reach lengths stratified into categories based on BFW. E.g., for 8-10 BFW, reach = 10x20 BFW. Reaches start at the closest pool tail to lowest point of the integrator reach.	20 to 40x average BFW with minimum length of 150 m for intensive Level III (TFW ambient monitoring protocols). Level II extensive surveys (USFS Region 6 protocol) collect data for entire length of response zone (gradients generally less than 8% and unconfined to moderate confinement) broken into reaches by major changes in channel type. Level III segments are nested within Level II reaches.	Reach lengths for biological monitoring activities are defined as 40X the average wetted width of the stream (minimum length of 150 meters). Reach lengths may vary for other projects depending on objectives (ex. TMDL modeling).	CMS and DOE: Reach lengths for all Biological Monitoring activities are defined as 40X the average wetted width of the stream (minimum length of 150 meters). DOE: Reach lengths representative of water quality conditions can be determined by location on the National Hydrography Data Layer (U.S. EPA).	For randomly selected sites: Reach length is 20x average bankfull width, with minimum length 150 meters and maximum length of 500 m. Habitat surveys and fish surveys based on length of Rosgen channel type.	Habitat surveys and fish surveys based on length of channel type. Reaches are defined as: stream segments between named tributaries, changes in valley and channel form, Major changes in vegetation type, or changes in land use or ownership. Is this the same protocol used by R6 Level II surveys?	Reach length is based on geomorphic and hydrologic characteristics. Is this the same protocol used by ODFW?	Reaches will vary in length according to the characteristics of the basin, valley, and channel. Sampling sites within reaches will vary according to the width of the stream channel. Sites will be 20x the average bandfull width with a minimum length of 150 m and a maximum length of 500 m. The starting point of the site will be measured with GPS and recorded as UTM.
Channel Cross Sections	Non-constrained reaches: Eleven evenly spaced transects are selected by dividing the reach into 10 equidistant intervals. Constrained reaches: Six cross-sections are evenly spaced by dividing the reach length by 5.	Uses methods adapted from Harrelson et al. Four cross-sections are measured within each reach. A cross-section is located at the widest point within each of the first 4 riffles.	Two protocols for Stream surveys. Level II extensive survey (based on USFS Region 6 protocols) take x-section at each major riffle with depth-distance recorded at ¼, ½, and ¾ of BFW. Level III intensive surveys (TFW ambient monitoring	Eleven evenly spaced transects are selected by dividing the reach into 10 equidistant intervals.	Ambient Biological Monitoring: Four cross sections per reach. Cross sections represent biological monitoring locations and where additional habitat characterizations are made. Cross sections are located based on a stratified selection method. The	Use AREMP protocols at randomly selected sites. Use DFG *California Salmonid Stream Habitat Restoration Manual* protocols (see parts 2 and 3) in tributary channel and habitat typing surveys. Manual is on DFG website:	Channel dimensions are collected including active channel width and depth, floodprone width and depth, and constraining terrace width and height. Collected at 5 transects on surveys (site surveys) or every 10 habitat units during basin surveys.	Not collected	Each sample site will be divided into 11 evenly-spaced transects by dividing the site into 10 equidistant intervals with "transect 1" at the downstream end of the site and "transect 11" at the upstream end of the site.

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	Cross sections are measured with a laser rangefinder.		protocol) – start at downstream and then every 100m at least 10 points measured with tape, stadia rod and level.		selection process targets in-stream riffle habitat and stratifying variables of: substrate size, water depth, and location within the riffle. Is the same method used by PIBO? EMAP and CMS: Eleven evenly spaced transects are selected by dividing the reach into 10 equidistant intervals.	http://www.dfg.ca.gov Measured with tape, stadia rod and level at the velocity cross over (tail crest) nearest each tenth habitat unit, and at each channel type change.	Compatible with type of constraining features and level I Rosgen typing combined with gradient and substrate.		
Longitudinal Profile	Stream length is measured along the thalweg using a laser range finder and an electronic compass. Shots are taken on an increment that is approximately 1/100 of the reach length.	Stream length is measured along the thalweg using a tape.	Level III surveys – throughout segment with points along thalweg at every 10 m and additional points at qualifying pools (tail crest, max depth, and head)	Stream length is measured along the thalweg. Profile measurements are taken on an increment that is approximately 1/100 of the reach length. Additional measurements are taken at pool tail crests, maximum pool depth, and pool head.	EMAP and CMS: Location of reach is identified and eleven equidistant transects are located. Several of the following physical habitat features are measured between and at each transect. ???	Stream length is measured along the thalweg	Profiles are developed based on habitat unit length and water surface gradient at each unit. Is profile measured along the thalweg?	Not collected	Lengths of sampling sites are measured along the thalweg.
Pool Frequency and Length	Two types of pools are measured: Must occupy greater than half the wetted width, be longer than wide, include the thalweg, and the maximum depth is at least 1.5 times the crest depth.	Two types of pools are measured: Must occupy greater than half the wetted width, be longer than wide, include the thalweg, and the maximum depth is at least 1.5 times the crest depth.	Level II survey pools defined same as AREMP. Level III survey – defined by size of pool (sq meters and residual depth criteria). Criteria also vary with categories of stream BFW	Calculated from thalweg depth and velocity measurements. No criteria for channel spanning, or longer than wide.	CMS: EMAP protocols Are there any criteria for channel spanning, longer than wide?	To be measured as a pool, must occupy greater than half the wetted width, be longer than wide, include the thalweg, and the maximum depth is at least 1.5 times the crest depth.	Are there any criteria for channel spanning? Channel geomorphic units are relatively homogeneous lengths of the stream that are classified by channel bed form, flow	Pool defined as being longer than the average wetted width unless unit is a plunge pool and habitat unit has to be channel spanning.	Estimated as the count of pools within a reach. To be counted, a pool must span more than half the wetted width, be longer than it is wide, and include the thalweg.

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	Length measured along the thalweg between the head and tail crest. or Pool defined as being longer than the average wetted width and habitat unit has to be channel spanning.	Length measured along the thalweg between the head and tail crest. or Pool defined as being longer than the average wetted width and habitat unit has to be channel spanning.	(TFW ambient monitoring protocols)			Length measured along the thalweg between the head and tail crest.	characteristics, and water surface slope of each unit in meters. Pools are longer than the active channel width, except for selected subunit pool types. The width and length are estimated every unit; it is estimated and verified every 10th unit. Lengths and widths are measured when surveying randomly selected sites under OR Plan protocols. Pool frequency is calculated based on total length of stream and on primary channel length.		Any depth requirements?
Pool depth	Pool tail crest, max pool depth, and pool head depth and locations are measured with laser rangefinder	Pool tail crest, max pool depths are measured with depth rod to the nearest cm.	Pool tail crest, max pool depth, and pool head locations measured with stadia rod for depth measurement.	Calculated directly from thalweg depth and velocity measurements.	CMS: EMAP protocols Are you using pool tail crest, max pool depth?	Pool tail crest, max pool depth are measured with stadia rod to the nearest 1/10 foot. Mean depth calc. measurements taken min. of 3 points at 3 cross sections in pool.	Pool tail crest, max pool depth: Maximum depth in pools measured to nearest 0.01 m. Depth at pool tail crest to the nearest 0.01 m in every pool habitat unit, with the exception of subunit pools.	Pool tail crest and maximum depth are measured with a depth rod.	Measured as residual pool depth, which is the difference between the maximum pool depth and the pool crest outlet depth. This metric is then used to estimate pool quality following the protocols in Platts et al. (1983).

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Gradient	Stream gradient is calculated as the rise of the streambed divided by the length of the sampling segment. Thus, the gradient is the slope of the streambed, not the water surface. Measure the elevation change twice, with the level at a different position each time and record to the nearest cm. Record the average if the two measurements are within 10 percent of each other. If not, take a third measurement and average it with one of the originals. Sufficient data is collected to report valley slope (straight line length) and reach slope (follows thalweg).	Stream gradient is measured from the water surface at the downstream end of the reach to the water surface at the upstream end using surveyor's rod and transit level. Measure the elevation change twice, with the level at a different position each time and record to the nearest cm. Record the average if the two measurements are within 10 percent of each other. If not, take a third measurement and average it with one of the originals. Sufficient data is collected to report valley slope (straight line length) and reach slope (follows thalweg).	Level II - gradient from USGS maps. Level III – use level and stadia rod throughout segment along bank at water level. Is gradient based on slope of streambed or slope of water surface?	Measured with laser range finder within sample reach, and calculated from maps using GIS. Field measurements are slope of water surface. Map info is based on changes in elevation from lower to upper transects.	Ambient Biological Monitoring: Sighted downstream from the top of the riffle at the transect sampled to the bottom of the riffle sampled. Four slope measurements are made. Percent slope is recorded at four locations in the reach. EMAP and CMS: Sighted downstream from the top of each transect to the next lowest transect. Ten measurements are made per reach and an overall slope for the reach is calculated. Percent slope is recorded between each of the segments. Is gradient based on slope of streambed or slope of water surface?	Measured with a sight level, tape, and stadia rod along the thalweg over two meander bends, or a distance ≥ 20 bankfull widths. Elevation is based upon water surface at velocity cross over (tail crests)	Expressed as the percent change in elevation over the length of the unit. Estimated with a clinometer using the scale on the right side in the viewfinder. Data are summarized across a reach, but detailed in the longitudinal profile. QA/QC with gradient on 7.5 min topo map. Gradient is the slope of the streambed.	Stream gradient is measured from 1:24000 USGS topo maps. It is calculated using rise/run of the stream reach (Channel Gradient is calculated by dividing the elevation gain by the mapped channel length for each reach). Gradient is the slope of the streambed.	Both valley gradient and channel gradient are measured as part of the hierarchical classification system. Gradients are expressed as percent slope and calculated from maps with GIS.
Sinuosity	Calculated as the length of the stream channel along the thalweg divided by the straight line distance between the top and bottom of the sample reach	Calculated as the length of the stream channel along the thalweg divided by the straight line distance between the top and bottom of the sample reach	Aerial photos How is it calcultated?	Calculated using longitudinal profile data. Sum of the distances between profile points divided by straight-line reach length.	EMAP and CMS: Sum of the distances between 11 transect thalweg measurements divided by the straight-line distance between the top and	Calculated for each reach from a 1:24000 USGS topo map. It is calculated by dividing the channel length of the reach by the mapped valley length.	Not recorded in the field, but can be calculated using 7.5 min topo maps. It is calculated by dividing the channel length of the reach by the mapped valley	Sinuosity is measured for each reach from a 1:24000 USGS topo map. It is calculated by dividing the channel length of the reach by the mapped valley length.	Not estimated, but can be calculated from information collected during classification.

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					bottom of the reach.		length.		
Discharge	Measured with flow meter (Marsh-McBirney or Pygmy). 10 cells are measured. Does this follow USGS protocol?	Discharge not measured.	Measured with Swoffer flow meter at representative locations within a reach or segment. 20 cells are measured. Does this follow USGS protocol?	Measured with flow meter (Marsh-McBirney or Pygmy). 10 cells are measured. Probably close to USGS protocol, but not sure if it matches exactly.	Ambient Biological Monitoring and EMAP and CMS: Discharge measured at the base of each site reach with a Swoffer or Marsh-McBirney flow meter. USGS methods for flow measurement are used. In addition, current velocity is measured at the locations where biological samples are collected along each of four transects (Biological Program only).	Measured with flow meter (Marsh-McBirney or Pygmy). Generally done at beginning of stream survey, or at bifurcations. In small streams, channel is squared using posts and plastic "wings" which are formed with blue tarps. Don't think they are using USGS protocol (construct a flume to measure stream flow).	Description of observed discharge condition. Best observed in riffles. If a gauging station is present, be sure to record the stage height. Does this follow USGS protocol?	Measured with flow meter (Marsh-McBirney or Pygmy). Twenty-five to thirty subsections are measured across the channel. Does this follow USGS protocol?	Measured at the downstream end of the distribution of each population or subpopulation (defined by the TRT). To the extent possible, the program will rely on USGS stream-gauge data. For streams with no USGS data, methods will follow procedures outlined in Chapter 14 in Bain and Stevenson (1999). Does this follow USGS protocol?
Large Wood	AREMP protocol adapted from ODFW. Length and DBH are estimated occularly for each piece that is at least partially within bankfull channel (including spanners and leaners). Measurements of length and dbh are taken on the first 10 pieces in the reach and every 5^{th} piece thereafter. Data on type, location, and configuration are recorded.	Length and circumference are measured for every piece up to 60 pieces in the reach, every other piece if 60 to 120 pieces, every third piece if 120 to 180 pieces, etc. Pieces are divided into those within the bankfull channel and those that extend above the bankfull channel (spanners and leaners). Minimum size criteria = 1 m long and 0.1 m in	Level II (USFS Region 6 protocols) number of pieces by the following classes: 12'' dia. 25' long; 24'' dia. 50' long; 36'' dia. 50' long. For both Level II and Level III all pieces with dia of 10cm at midlength and ≥ to 2m are measured and data recorded by position in the channel, type of wood and decay state (TFW protocols). Log jams recorded separately and	LWD must first be partially in the base flow of the channel. LWD is tallied over the entire length of the reach. Length, large end diameter, and small end diameter are visually estimated and then tallied by size class. There are twelve size classes for wood. Diameter at large end: 0.1 to 0.3 m 0.3 to 0.6 m 0.6 to 0.8 m	DOE: Large Woody Debris i) size/length ii) decay class iii) % in water iv) structural configuration EMAP and CMS: LWD must first be partially in the base flow of the channel. LWD is tallied over the entire length of the reach. Length, large end diameter, and small end diameter are visually estimated and then	Use DFG *California Salmonid Stream Habitat Restoration Manual* protocol (see part 3) for measuring near- stream stems and downed wood for potential recruitment estimates. Also used to estimate in stream wood at a reconnaissance level. Use FFFC protocols for secondary and tertiary level measurements of in stream wood. Recon protocol (part	. The ODFW counts all pieces of dead wood longer then 3m (and root wads <3m long) and larger than 15 cm in diameter that touch, are within, or are above the active channel. The diameter is measured at a point 2 m from the bole. Type, location, and configuration of each piece are recorded. Since all pieces are classes by diameter and length, data can be queries for LWD	R6 measures the wood diameter at a point 50' from the large end (35' for eastside streams), allows for counting standing or spanning trees as LWD if the base of the tree is within the bankfull channel width. LWD (within the category for >24" dia and 50' long, on westside) that is shorter than50' is counted if the length is 2X bankfull width and meets the diameter	Estimated as the number of pieces of LWD per stream mile within a reach. The program defines LWD as any piece of wood with a diameter greater than 10 cm and a length greater than 1 m. It can occur as a single piece, an aggregate, or as a rootwad. Program follows methods described in BURPTAC (1999). Is there only 1 size class for LWD?

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	Minimum size criteria = 3 m long 0.3 m dbh.	diameter as measured one-third of the way up from the base. (Can also partition data the same way AREMP does).	require minimum of 10 pieces of wood meeting the 10cm and 2m criteria. Key pieces recorded (TFW criteria)	> 0.8 Length: 1.5-5 m 5-15 m > 15 m	tallied by size class. There are twelve size classes for wood. What are the size classes?	III of manual): 20% sample in each stream reach (defined by Rosgen channel type) – count pieces (1-2 ft in diam, 3-4 ft, > 4 ft, length categories: 6-20 ft long, >20ft long). Also do a LWD count in every habitat unit (categorized as either small or large). 2nd level: do this in reaches where they are interested in movement of large wood – measure every LWD. 3rd level: tag every piece (research effort).	that meets the 2X BFW. Is there only 1 size class for LWD?	requirement. R6 tallies the pieces of wood (small, medium, and large) within bankfull that meet the following criteria for east and westside forests: Eastside Forests: S = Diameter > 6 in., at a length of 20 ft. from the large end M = Diameter > 12 in., at a length of 35 ft. from the large end L = Diameter > 20 in., at a length of 35 ft. from the large end. Westside Forests: S = Diameter > 6 in., at a length of 20 ft. from the large end M = Diameter > 12 in., at a length of 35 ft. from the large end L = Diameter > 20 in., at a length of 35 ft. from the large end. .	

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Bankfull width: depth	Calculate BF width to depth ratios at every cross section. Eleven depth measurements are taken between and including the BF points at each transect for determination of mean bankfull depth.	Mean bankfull depth determined from 10 measurements of depth in the cross section, taken at equal distances. First measurement is randomly chosen. A cross-section is located at the widest point within each of the first 4 riffles.	BFW at every x-section	Calculate BF width to depth ratios at every cross section.	Ambient Biological Monitoring: Bankfull width and depth are measured at each of four transects. Bankfull width and depth measurements are maintained as separate characterizations of the stream channel. CMS: EMAP protocol	Mean bankfull depth determined from 10 measurements of depth in the cross section, taken at equal distances. Calculate BF width to depth ratios at every cross section.	"Active channel width" and "active channel height" are measured in every 10th unit and at start of new reaches.	Bankfull width to depth ratio is calculated at each measured unit (10% of all units). Mean bankfull depth is calculated by taking the average of the measurements at ¼, ½, and ¾ points across the channel.	The ratio is expressed as bankfull width divided by the mean cross-section bankfull depth. The ratio will be measured at the 11 transects within each sampling site. Methods follow those described in BURPTAC (1999).
Entrenchment ratio	Floodprone width divided by bankfull width, as determined from the cross sectional profiles. FP width is calculated based on measurements of two randomly selected transects within a given reach.	Floodprone width divided by bankfull width, as determined from the four cross sections. Floodprone width measured with at tape if possible and estimated if not (too brushy or wide riparian area.	Same as AREMP. Done at all x-sections.			Floodprone width divided by bankfull width, as determined from the cross sectional profiles.	Floodprone width divided by bankfull (active channel) width.	Floodprone width divided by bankfull width, as determined from the cross section information taken at measured units. Floodprone measured at 2x max bankfull depth.	Not an identified variable, but it is a component of the Rosgen channel classification, which is recorded.

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Substrate	Percent Surface Fines in Pool Tails (1st 12 scour pools : Using a modified version of USFS R5 SCI protocol. Grids are placed at 25%, 50%, and 75% of the distance along the pool-tail crest. Fines are defined at both < 2 mm and < 6 mm (to allow direct comparison with PIBO) Substrate particle size (D_{50}) determined by measuring 11 particles at systematic intervals within the 11 cross section transects using EMAP protocols	Percent Surface Fines in Pool Tails (1st four scour pools) Using a modified version of USFS R5 SCI protocol. Grids are placed at 25%, 50%, and 75% of the distance along the pool-tail crest. Fines are defined at both < 2 mm and < 6 mm (to allow direct comparison with AREMP) 25 particles are sampled from each of the first 4 riffle/runs. Substrate Particle Size (D_{16}, D_{50}, and D_{84} in riffles/runs): uses Wolman (1954) method.	Level II survey – Wolman 100ct pebble counts from 2 riffles in each reach and observations of dominant/ subdominant particle size for all habitat units. Level III same as above for pebble counts with at least three for each survey segment (downstream, mid segment, and upstream) Embeddedness data also collected with each pebble count for all particles greater or equal to 64mm by high med low based on observation of particle. Pebble count data represented in cumulative frequency curves for calculation of D_{50} and percent fines at user selected particle size criteria	Substrate particle sizes are measured at five locations equidistantly placed on each of the eleven transects and at an additional 10 transects equally spaced between the primary 11 transects. A total of 105 pebble counts are taken in the reach. An observation for the particle size at the base of a stadia rod placed on the left edge, right edge, at 25% across, at 50% across, and at 75% across. Size Classes include: Bedrock (smooth), Bedrock (rough), Boulder, Cobble, Coarse Gravel, Fine Gravel, Sand, Silt/Clay/Muck, Wood, Other. This is different than what AREMP and PIBO do.	DOE: <u>Ambient Biological Monitoring</u> - Substrate size measurements are made at four transects in a reach within a 60 cm grid hoop at each location. 50 equidistant observations are made within this sampling area. Size Classes include: Bedrock (smooth), Bedrock (rough), Boulder, Cobble, Coarse Gravel, Fine Gravel, Sand, Silt/Clay/Muck, Wood, Other. We also take pebble counts along each transect (4 transects). We currently do 50 counts along the bankfull width. <u>EMAP and CMS</u>: Same as Oregon DEQ and Oregon Plan,	Substrate Characterization i) Twenty equidistant points are sampled with a dropped rod at a velocity cross- over transect. ii) substrate embeddedness is estimated at each velocity cross over (tail crest) by measuring the depth of embeddedness of at least five D50 – D84 sized particles. The estimates are binned in increments of 25% (0-25% = Category 1; 26 – 50% = Category 2) iii) substrate composition is visually estimated in each fully measured habitat unit and categorized as dominant and co-dominant..	Percent distribution by streambed area of substrate material in six size classes: silt and fine organic matter, sand, gravel (pea to baseball; 2-64mm), cobble (baseball to bowling ball; 64-256mm), bounders, and bedrock. Estimate distribution relative to the total area of each habitat unit (wetted area). Round off to nearest 5 percent.	R6 uses the Wolman pebble count technique. It is performed two times in each stream reach at representative riffles with at least 100 pebbles collected at each count.	The program measures three substrate variables, depth fines, dominant substrate, and embeddedness. Depth fines will be measured with McNeil core samplers following methods described in Schuett-Hames et al. (1999). Three subsamples will be collected from spawning gravels within each site. The volumetric method will be used to process samples sorted via a standard set of sieves (64.0 mm, 16.0 mm, 6.4 mm, 4.0 mm, 1.0 mm, 0.85 mm, 0.50 mm, 0.25 mm, and 0.125 mm). Pebble counts will be used to identify substrate composition. Substrate will be measured at five equidistant points along each of the 11 transects. Following Bunte and Abt (2001), a 60 x 60-cm sampling frame will

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									be used to sample substrate at each point along a transect. The sampling frame will be divided into four grid points by spacing the elastic bands 30 cm from each other. Embedded will be measured with the methods described in MacDonald et al. (1991). The method involves the use of a 60-cm-diameter hoop as the basic sample unit. Embeddedness will be collected within riffles in the upstream and downstream portions of each reach.
Water Chemistry	Field measured conductivity, water temperature, DO, conductivity, and pH using calibrated meters at downstream end of each reach.	Conductivity and alkalinity measured using calibrated meters and titration kits.	Field measured conductivity, water temperature, conductivity, and pH measured using calibrated meters. at downstream end of each reach.	Temperature using thermographs, from roughly July 1 to Sept 15th , pH, conductivity, dissolved oxygen, turbidity, total suspended solids,	Temperature) using thermographs, from when to when? , pH, conductivity, dissolved oxygen, turbidity, total suspended solids, fecal coliform	Conductivity, water temperature, DO, conductivity, and pH measured using calibrated meters at random sites. In tributary surveys	Not collected	Not collected	The program will measure temperature (MDMTand MWMT), turbidity, pH, dissolved oxygen, nitrogen, and phosphorus. Data loggers will be used

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	Water temperature measured using Hobo temps from July 1 to Sept 1 at most sites. Laboratory samples collected and analyzed for Total Kjeldahl Nitrogen: and Total Phosphorus.	Water temperature measured using Hobo temps from July 1 to Sept 1 at most sites		fecal coliform bacteria, ammonia-N, nitrate+nitrite-N, total nitrogen, total phosphorus, soluble reactive phosphorus. Field meters for pH, conductivity, and turbidity. Field titration for dissolved oxygen. Lab analysis at DEQ Laboratory or EPA contract lab for remaining chemical parameters. DEQ Ambient Surveys: 152 sites sampled quarterly to monthly for the same parameters listed above.	bacteria, ammonia-N, nitrate+nitrite-N, total nitrogen, total phosphorus, soluble reactive phosphorus, and at most stations, discharge. Dissolved metals are monitored bi-monthly at a few stations. using meters, titration, lab analysis?] Monitor about 82 stations each year, twenty on a one-year basis, 4 on a five-year rotation, and 58 are monitored continuously. Washington's draft Water Quality Index (WQI) is a unitless number ranging from 10 to 100; a higher number is indicative of better water quality relative to expectations. Multiple constituents are combined and results aggregated over time to produce a single score for each sample station. http://www.ecy.wa.gov/apps/watersheds/wqi/WQIOverview.html	temperature is measured each tenth habitat unit. Use thermographs during the summer (May – Oct).			to measure MWMT and MDMT following methods outlined in Zaroban (2000). At a minimum, loggers will be placed at the upstream and downstream ends of reaches. Turbidity will be measured with a portable turbidimeter (calibrated on the nephelometric turbidity method) following protocols described in Chapter 11 in OPSW (1999). At a minimum, turbidity will be measured at the downstream and upstream ends of each reach. Procedures described in OPSW (1999) will be used to measure pH (Chapter 8), dissolved oxygen (Chapter 7), nitrogen, and phosphorus (Chapter 10). Dissolved oxygen will be measured with the Winkler Titration Method. Nitrogen will be

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									described as nitrate/nitrites and Kjeldahl nitrogen. Phosphorus will be described as total phosphorus and orthophosphates.
Annual Water Temperature	Uses average weekly temperatures and average weekly maximum temperatures. Data acquired from thermographs placed in the lowest portion of the watershed on federal land.	Uses average weekly temperatures and average weekly maximum temperatures. Data acquired from thermographs placed in the lowest portion of the watershed on federal land. Currently collecting "B" quality data using Oregon DEQ protocols. Data is summarized following DEQ standards for each State.	Hobo-Temp continuous data loggers placed in targeted study reaches at downstream end (We will be developing a monitoring protocol and sampling design for this in the future)	Continuous temperature loggers measure every half hour from early June to late September.	DOE and CMS: Continuous temperature loggers from early June to late September.	Hobo-Temp continuous data loggers placed in targeted study reaches at downstream end	Stream temperature recorded only during stream survey (measured at each reach change or once per page of Unit 1 data.)	Uses 7-day average minimum and maximum water temperatures obtained from a recording thermograph placed in the surveyed stream from mid June through late September.	The program measures MDMT and MWMT with data loggers placed at the upstream and downstream ends of each reach. From when to when?
Benthic Periphyton	EMAP protocol. At each transect, periphyton is removed from a 12 cm^2 area. Subsamples are composited into a single sample for the reach. *We will likely switch to Hawkins and Stevenson protocol in 2003.*	Switched from EPA's EMAP method in 2001 to Stevenson and Hawkins protocol in 2002.	Not collected	EMAP protocol. At each transect, periphyton is removed from a 12 cm^2 area. Subsamples are composited into a single sample for the reach.	CMS: EMAP protocol. At each transect, periphyton is removed from a 12 cm^2 area. Subsamples are composited into a single sample for the reach.	Not collected	Not collected	Not collected	Not collected.
Aquatic	Two subsamples are	Two subsamples are	Currently, samples	Two subsamples are	Ambient Biological	RAPID EPS	Not collected	Not collected	Not collected.

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Benthic Macroinvertebrates	taken in each of four riffles in the reach using kicknet. The eight subsamples are composited into a single sample for the reach (Hawkins et al. revised protocol). Samples are analyzed by the National Aquatic Monitoring Center using a minimum of 500-organism count. The 11 standard methods suggested by Karr (1997) and a RIVPACS score (where applicable) are reported.	taken in each of four riffles in the reach using kicknet. The eight subsamples are composited into a single sample for the reach (Hawkins et al. revised protocol). Samples are analyzed by the National Aquatic Monitoring Center using a minimum of 500-organism count. The 11 standard methods suggested by Karr (1997) and a RIVPACS score (where applicable) are reported.	from reaches under 3000 m in elevation. Total of 4 to 5 – 2 sq ft samples taken with D-frame net (500 µm). Samples collected from riffles distributed throughout the reach. Sub-samples kept separate and all specimens are picked and identified. Samples will be composites for data analysis and a random sampling program will select a 500-specimen sample. Data analysis for the Washington National Parks network has been proposed to use Hawkins models (RIVPACS approach) North Cascades NP is currently developing RIVPACS type model for the park and adjacent USFS land and also will be evaluating the multimetric approach.	taken in each of four riffles in the reach using kicknet. The eight subsamples are composited into a single sample for the reach (Hawkins et al. revised protocol). Samples are analyzed by the National Aquatic Monitoring Center using a minimum of 500 organism count EMAP Two strategies for sampling: 1) eight, one-square foot samples randomly selected from four to eight riffles and composited, and 2) single square-foot samples collected from each of the eleven transects (location along transect alternates from left bank, center of stream, and right bank).	Monitoring: Four riffle kicknet samples collected at each site are sub-sampled using a 500-organism count. Pools are only sampled in specific circumstances/ projects The riffle collection technique complies with the methods required for generating RIVPACS scores. Macroinvertebrates are removed from a minimum of two randomly chosen squares in a sub-sampling grid containing 30 squares. All organisms are removed from randomly chosen squares until a minimum of 500+macroinvertebrates is picked and the process is continued to include all remaining organisms in the selected squares. Taxonomic effort is the Northwest standard. EMAP and CMS: Two strategies for sampling: 1) eight, one-square foot	Protocol.			

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					samples composited collected from four transects, and 2) single square-foot samples collected from each of the eleven transects (location along transect alternates from left bank, center of stream, and right bank). Application of RIVPACS model (being evaluated).				
Fish and Aquatic Amphibians	A single pass with an electrofisher is made between each transect. All animals identified and enumerated. Approximately 10-20% of the fish are measured, and their condition estimated using displacement. Snout-vent lengths are measured for all aquatic amphibians.	Not collected	Fish survey protocols under development for summer stream resident fish in wadeable streams with gradients less than 8%. Probabilistic extensive sampling design to provide reach estimators of frequency of occurrence (single pass diver surveys from 100m segments). Also reach estimators for abundance of fish in pools using 4-pass diver surveys calibrated by electrofishing population estimates. Amphibians – only tailed frogs as tadpoles occur in	DEQ Oregon Plan & EMAP: Single pass electroshocking through 40x channel width reach. All individuals of each species counted and lengths measured. ODFW: Three pass electrofishing surveys or snorkel surveys. Only salmonids counted.	EMAP and CMS: Single pass electrofishing through 40x channel width reach. All individuals of each species counted and lengths measured.	Presence/ absence (area of occurrence) of specific native and exotic species. Use bank estimates, dives, and e-fishers.	Random habitat surveys are based on randomly selected GIS point. Fish and aquatic amphibians are also surveyed during these surveys. At least 3 pools and 3 riffles totaling a minimum of 60 m stream length are sampled. Sample at least 15 meters of the fast water unit immediately above the pool and record the fish captured. Walk upstream to the next pool and sample it and the fast waters unit above. Consecutive sampling is preferred. Continue sampling until 3 pool-fast waters sequences	Snorkeling, electrofishing, or hook and line sampling is done at each measured pool and every other measured riffle to identify species presence or absence	Not collected.

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			BMI Samples.				have been sampled. If a fish species or life history stage not observed in the 1st 4 units is captured in the 5th or 6th unit, sample another pool and fast water unit.		
Terrestrial Amphibians	Time and area-constrained searches are conducted for at each transect. Search begins at the wetted edge and continues up the bank on either side of the stream for five minutes (ten minutes total at each transect). Special attention is given to seeps, springs, and other high quality habitats. Snout-vent lengths are measured for all captured amphibians.	Not collected	Not collected	Not collected	Not collected	Not collected	Not collected	Not collected	Follows methods in BURTAC (1999). Stability is based on "natural" conditions (e.g., vegetation), not "unnatural" conditions such as car bodies, riprap, and concrete. Method applies to both banks and is measured at the 11 transects within each site.
Road Density	Determined from GIS layer. Road density (miles of road per square mile of watershed) is calculated for both the riparian area (< 100m from stream) and upslope (> 100m from stream) For these analyses, the stream layer was buffered 100 meters each side and	Determined from GIS layer. Road density (km of road per square km of watershed) is calculated for riparian road density (within 100 m of stream channels (1:24000 map) and for the entire watershed upstream of the integrator reach. Densities are		GIS coverages. Kilometers per hectare within watershed above sample point.	CMS: GIS coverages Which densities are calculated?	Not collected	Not collected	Not collected	Not collected specifically, but is captured in the description of bed-form types (Bisson and Montgomery 1996) in the classification system.

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	overlaid with the roads to calculate road density	calculated using individual Forest layers cardiographic feature files (CCF) layers).							
Stream Crossing Density	The number of road crossings was estimated by finding the intersection of roads and streams on GIS layers.	The number of road crossing was estimated from the forest and CCF layers.	At sub-basin level from GIS. Also with field notes of any channel influences.	GIS coverages	CMS: GIS coverages	At sub-basin level from GIS. Also with field notes of any channel intersections	All stream crossings are noted during the survey, and details on bridges, culverts are recorded.	Not collected	Not collected.
Vegetation seral stage and series	Upslope vegetation (all vegetation > 100 m from the stream channel) and riparian vegetation data (all vegetation < 100 m from the stream channel) were collected from the vegetation layer developed by the Interagency Vegetation Mapping Project (IVMP) in Oregon and Washington, and the CalVeg layer developed in California. Both layers were constructed using Landsat Thematic Mapper remote sensing data. Vegetation was classified into the following categories: *Non-Forested/Grass-*	Four methods are used to sample riparian using slightly modified versions of survey techniques described by Winward (2000). The Greenline method uses a line-transect method to characterize vegetation community types (nine classifications are used within the study area) along the first line of perennial vegetation next to the stream channel. The data are summarized using a stability, seral, and wetland rating. The vegetation cross-section method characterizes community types along 5 cross-sections within the	Level III surveys – 20x20m plots on left and right banks of each x-section. Over and understory % cover estimated by dominant species and seral class. Stream canopy closure by densiometer with 4 measurements – upstream, downstream, left and right banks from center of channel at each x-section.	Type of vegetative cover and the type of land use (e.g., forested, urban, agriculture, open) across the landscape. Proportion of known geographic area - Remote sensing Riparian Vegetation Structure i) canopy ii) understory iii) ground cover Canopy Cover i) center of stream readings ii) left bank/right bank readings iii) percent solar radiation (solar pathfinder)	CMS: Type of vegetative cover and the type of land use (e.g., forested, urban, agriculture, open) across the landscape. Proportion of known geographic area - Remote sensing , some information from EMAP.	Type of vegetative cover and the type of land use (e.g., forested, urban, agriculture, open) across the landscape. Proportion of known geographic area - Remote sensing Riparian Vegetation Structure i) canopy Canopy Cover i) center of stream readings ii) left bank/right bank readings iii) percent solar radiation	A general description of the riparian zone within one active channel width of either side of the channel is provided for each reach. Detailed riparian surveys are also conducted. Vegetation type: N *No Vegetation* (bare soil, rock) B *Sagebrush* (sagebrush, greasewood, rabbit brush, etc.) G *Annual Grasses, herbs, and forbs*. P *Perennial grasses, sedges and rushes* S *Shrubs* (willow, salmonberry, some alder) D *Deciduous* Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other		The program will collect information on distribution, life-stage survival, redd counts, age-structure, hatchery or wild origin, parr abundance, and smolt abundance. These data will be collected using weirs, traps, electrofishing, snorkeling, seines, and census techniques. Amphibians will not be collected.

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	Forb, *Pure Broadleaf* (> 90 % broadleaf), *Mixed* (Stands that contain both conifer and broadleaf species), and *Pure Conifer* (> 90% coniferous species). Conifers in both pure and mixed stands were classified by seral stage using the following definitions: *Early Seral* - recent clear cuts to stands with trees less than 25 cm (10 in) (dbh). Approximate stand ages from 0 to 24 years old. *Mid Seral* - Stands trees from 26 cm to 52 cm (10 - 20 in) dbh. Approximate stand ages from 24 to 80 years old. *Late Seral* - Stands with trees greater than 53 cm (20 in) dbh. Approximate stand ages >80 years old.	riparian area and is summarized using a wetland rating. The Woody Regeneration method tallies the number and age of woody plants along the greenline and is summarized as the ratio of young to old plants. Effective ground cover is collected along the vegetation cross-sections using R4 Soils protocols.					deciduous spp.) M *Mixed* conifer/deciduous (approx. 50:50 distribution) C *Coniferous* Dominated (canopy more than 70% conifer) Size Class. Use groupings for the estimated diameter at breast height (dbh) expressed in cm of the dominant trees. Estimate diameter of young conifers below the first whorl of branches. Enter just the first number(s) of any choice. 1- 3 Seedlings and new plantings. 3-15 Young established trees or saplings. 15-30 Typical sizes for second growth stands. West side communities may have fully closed canopy at this stage. 30-50 Large trees in established stands. 50-90 Mature timber. Developing understory of trees and shrubs. 90+ Old growth.		

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							Very large trees, nearly always conifers. Plant community likely to include a combination of big trees, snags, down woody debris, and a multi-layered canopy. *These size classes correspond to dbh estimated in inches of: <1, 1-5, 6-11, 12-20, 21-35, and 36+ respectively*. The detail riparian inventories consist of a series of belt transects extending across the riparian zone perpendicular to the stream channel for 30 m on each side every ½ to 1 km. Information collected includes tree size and type for all large trees > 0.03m dbh in each of the three 10m zones. Other data collected include geomorphic surface, percent slope, percent grass and forb cover, percent shrub cover, and canopy cover.		
Channel connectivity with	Entrenchment ratio (valley width divided by channel width)	Not calculated	Aerial photos, maps, field observations	Not collected	CMS: GIS coverages, remote sensing, field observations,	Not collected	Geomorphic reach descriptions include valley width relative	Not collected	Not collected

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floodplain in unconstrained reaches	measured in conjunction with channel cross section and profile		Entrenchment by Rosgen method at representative x-sections.		SSHIAP connectivity inventory (hydromodification methodology)		to stream width, terrace height, and whether the stream is unconstrained single channel, anastomising, or braided. The surveys also describe the length and type of secondary channel and presence and type of off-channel habitats.		
Landslides	Still in development	Still in development		Not collected	CMS: in development [Frequency: mean # events/year by landslide type (e.g. shallow rapid) Return interval: years between events Extent: area disturbed per time period or event % landslide prone geology % steep slopes (>70%)]	NCWAP does this with its geologic component at the basin and subbasin scale as we rotate through our 31 watersheds.	Landslide location, type, and level of activity are required comment fields.	Not collected	As part of the classification system, riparian cover group and riparian community type will be collected within reaches following methods in Overton et al. (1997). Percent vegetation altered will also be measured within each site following methods in Platts et al. (1987).
Bank Angle	Not collected	Protocols are modified from Platts et al. 1987. Angles are recorded for both banks at a minimum of 20 transects located at an interval equal to the bankfull width.	Not collected	EMAP protocol	CMS: EMAP protocol	Not collected	Not collected	Not collected	Road density (mi/mi^2) is calculated as the total length of roads within a watershed divided by the areas of the watershed using GIS. The riparian-road index (RRI) is expressed as the total mileage of roads within riparian areas divided by the total

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									number of stream miles within the watershed. Riparian areas are defined as those falling within the federal buffers zones.
Bank Stability	Not collected	Protocols are described by Bauer and Burton, 1993 and Overton et al. 1997. Stream banks are classified into feature types, cover, stability class, and are then rated for stability. All measurements are done on a series of 30 cm wide at the same locations as bank angles	Length of eroded bank is recorded for Level II and Level III surveys	EMAP protocol	CMS: EMAP protocols	Estimated based upon categorization of stream bank composition (bedrock – silt)	Percent of actively eroding banks is recorded for every habitat unit. Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin.	Measure the linear distance of actively eroding banks along both sides of every measured channel unit and tally separately (left bank, right bank, total for both banks). Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin.	Not collected.
Bank Type	Not collected	Classify the stream banks at each transect location into various types based on the fluvial processes forming the stream banks.	Not collected	EMAP protocol	CMS: EMAP protocol.	Not collected	Not collected	Not collected	Measured indirectly as Rosgen channel type (which includes entrenchment) and directly as the number of off-channel habitats (side channels, backwater areas, alcoves or side pools, off-channel pools, off-channel ponds, and oxbows) within a reach. This measure is specific to channels with gradients <3%.
Bank Materials	Not collected	Protocols have not yet been developed. PIBO will probably	Not collected	Not collected	Not collected	Not collected	Not collected	Not collected	Not collected.

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		collect this information at each of the stream bank transects..							
Impervious surfaces	Not collected	Not collected	Locations, size, type at the catchment level. Field notes on stream influence from reach level surveys.	GIS coverages	CMS: GIS coverages, remote sensing (Hard surfaces such as roads, rooftops, and parking lots. % impervious cover which affect the pattern and extent of factors such as surface runoff (hydrograph), sedimentation, and stream temperature	Not collected	Not collected	Not collected	Not collected.
Geomorphic index	Not collected	Not collected	Not collected	Not collected	CMS: A measure of stream channel structure in floodplain areas *and connectivity to floodplain.* Remote sensing, field sampling	Not collected	Reach descriptions are based on Grans and Swanson geomorphic stream types.	Not collected	Basin area, basin relief, and drainage density are geomorphic features that are part of the classification system. These features are measured according to procedures in Bain and Stevenson (1999). Valley characteristics such as valley bottom type, valley bottom width, valley bottom gradient, and valley containment are also part of the classification system.
Restored stream miles	Not collected	Not collected	Observation of locations and mapping in Level III surveys. Miles of	Not collected	CMS: Linear miles of restored habitat. % area reconnected, # of reconnected	Not collected	Stream restoration monitoring is also conducted through this project.	Not collected	Not collected in this program.

Parameter Measured	Aquatic and Riparian Effectiveness Monitoring Program (AREMP)[2]	Pacfish/Infish Biological Opinion (PIBO)[3]	National Park Service (North Cascades NP)[4]	Oregon DEQ and Oregon Plan[5]	Washington DOE and Comprehensive Monitoring Strategy[6]	California North Coast Watershed Assessment[7]	Oregon Dept. Fish & Wildlife Stream Survey and BLM[8]	FS R6 Level II Stream Survey[9]	Action Agency (BPA, COE, BOR) and NMFS Research Monitoring and Evaluation Plan
			side channels measured in Level II surveys		patches				
Total or partial blockages to salmon migration and rearing	Not collected	Not collected	Observations during field surveys sometimes verified by fish survey data above barriers. Also WA stream catalog	Not collected	CMS: Frequency of barriers by type and level of obstruction (total or partial). Field sampling, WDFW/WSDOT barrier inventory	Not collected	Potential natural or human created barriers are recorded and details are recorded as part of the stream survey.	Not collected	Artificial barriers (road crossings, dams, and fishways) will be identified following procedures in WDFW (2000). Artificial barriers will be assessed within each reach.

[1] Please contact Steve Lanigan (Hslanigan@fs.fed.usH, 503.808.2261) with any revisions
[2] Kirsten Gallo, Hkgallo@fs.fed.usH
[3] Rick Henderson, rhenderson01@fs.fed.us
[4] Reed Glesne, reed_glesne@nps.gov
[5] Rick Hafele, hafele.rick@deq.state.or.us
[6] Rob Plotnikoff, Hrpl0461@ecy.wa.govH or Steve Leider, steve.leider@esa.wa.gov
[7] Scott Downie, sdownie@dfg.ca.gov
[8] Kim Jones, jonesk@fsl.orst.edu
[9] Deborah Konnoff, dkonnoff@fs.fed.us